

Executive Summary

Total Maximum Daily Loads of Nutrients and Dissolved Oxygen Under Low-Flow Conditions in the Christina River Basin, Pennsylvania, Delaware, and Maryland

Introduction

The Environmental Protection Agency Region III (EPA) establishes these Total Maximum Daily Loads (TMDLs) for nutrients and other oxygen demanding pollutants in order to attain and maintain the applicable Water Quality Standards (WQS) for dissolved oxygen (DO) in the Christina River Basin under low-flow conditions (equivalent to the minimum seven-day low flow expected to occur every 10 years - conditions used to establish National Pollution Discharge Elimination System (NPDES) permits). EPA has established these TMDLs in cooperation with the Pennsylvania Department of Environmental Protection (DEP), Delaware Department of Natural Resources and Environmental Control (DNREC), Maryland Department of the Environment (MDE) and the Delaware River Basin Commission (DRBC). As part of these TMDLs, EPA has allocated specific amounts of nutrients and other oxygen demanding pollutants to certain point and nonpoint sources necessary to restore and maintain the applicable WQS. These TMDLs recommend that eight facilities, seven in Pennsylvania and one in Maryland, have their NPDES permits modified when next reissued to reduce the amounts of pollutants that may be discharged.

During permit reviews for several of the facilities covered by January 19, 2001 TMDLs, it was discovered that flow rates used in the original TMDL calculations were in error. As a result, model runs using updated flow figures for these facilities were performed and revisions to the TMDL recommendations for the Brandywine Creek portion of the Christina River Basin were made.

A related, but separate, effort is underway to establish TMDLs for nutrients, DO and other pollutants causing water quality problems under high-flow conditions. EPA expects these high-flow TMDLs to be completed by December 2004.

Summary of TMDL Development and Public Participation

In 1991, at the request of DNREC and DEP, DRBC agreed to coordinate water management issues in the “interstate” Christina River Basin. The issues included monitoring, modeling, and pollution controls; balancing the conflicting demands for potable water while maintaining necessary minimum requirements to sustain aquatic life; protection of vulnerable, high quality scenic and recreational areas; restoration of wetlands and other critical habitats; and implementation of Delaware's Exceptional Recreational or Ecological Significance (ERES) objectives. DRBC facilitated a series of meetings with DNREC, DEP, EPA, Chester County Water Resources Authority (CCWA) and the United States Geological Survey (USGS). The two states, DRBC, EPA and other government agencies reached agreement in late 1993 to initiate a

cooperative and coordinated monitoring and modeling approach to develop and establish TMDLs to address water quality problems occurring at low-flow conditions by late 1999.

Both Pennsylvania and Delaware have identified multiple segments and pollutants in the Christina River Basin on their respective lists of impaired waters still requiring the development of a TMDL. Based on available information, Pennsylvania identified 24 stream segments on its 1998 303(d) lists while Delaware identified 15 stream segments on its 1998 303(d) list as not meeting WQS for nutrients and low DO within the Christina River Basin.

Concurrent with the water quality improvement activities taking place within the Christina River Basin, EPA settled two civil lawsuits regarding EPA's oversight of the TMDL programs of Pennsylvania and Delaware. Both suits alleged violations of the Clean Water Act (CWA), the Endangered Species Act (ESA) and the Administrative Procedures Act (APA). The settlement of the Pennsylvania matter, American Littoral Society and the Public Interest Research Group v. EPA, Civil No. 96-489 (E.D. Pa), was entered on April 9, 1997. The Pennsylvania TMDL settlement requires certain numbers of TMDLs by certain dates but gives discretion to Pennsylvania and EPA as to which TMDLs must be completed. The settlement of the Delaware lawsuit, American Littoral Society and Sierra Club v. EPA Civil Action No. 96-591 (SLR) (D.De), was entered on August 9, 1997. The Delaware TMDL settlement sets forth specific deadlines for EPA relating to specific waters and TMDLs in the Christina River Basin. Under the schedule set forth the settlement, Delaware was to establish low-flow TMDLs for all water quality limited segments (except for those impaired by bacteria), including Brandywine Creek, Christina River, Red Clay Creek and White Clay Creek, by December 31, 1999. The Delaware settlement also expects Delaware to establish the high-flow TMDL by December 31, 2004. Pursuant to the Delaware agreement, EPA is required to establish TMDLs within one year should Delaware fail to do so.

Despite best efforts by DRBC, EPA, Delaware and other participants, including the use of expert contractors from Tetra Tech and Widener University, the low-flow TMDLs for the Christina River Basin were not completed by December 1999. EPA thereafter assumed the lead to establish these TMDLs.

EPA held two public information meetings on preliminary draft Christina River Basin TMDLs on July 18-19, 2000 in West Chester, PA and Wilmington, DE respectively. After making appropriate changes, EPA opened the formal public comment period on the proposed TMDLs with two public hearings on August 29-30, 2000, again in West Chester, PA and Wilmington, DE respectively. As advertised in local papers, EPA held the comment period for the draft TMDLs open through October 15, 2000. EPA received numerous comments from both the public hearings and during the public comment period. EPA reviewed and considered those comments in making its final decision for these TMDLs. EPA has prepared a public comment responsiveness summary which accompanies the final TMDL Decision Rationale document.

For the revised TMDLs, EPA issued a public notice of the proposed revisions on March 1, 2002 for a 30-day public comment period. The notice was published in the Chester County

Community Newspaper Group and the Wilmington News-Journal. Copies of the notice were also mailed to each affected point source discharger in the Christina River Basin. One set of comments were received and EPA has prepared a response to those comments which accompanies this revised TMDL Decision Rationale document. Because of the limited changes being made to the TMDLs and the few comments received, EPA determined that the proposed TMDL revisions could proceed without the need for a public hearing.

Applicable Water Quality Standards for TMDLs

The CWA requires States to adopt WQS to define the water goals for a waterbody by designating the use or uses to be made of the water, by setting criteria necessary to protect the uses and by protecting water quality through antidegradation provisions. These WQS serve dual purposes: they establish water quality goals for a specific waterbody, and they serve as the regulatory basis for establishing water quality-based controls and strategies beyond the technology-based levels of treatment required by sections 301(b) and 306 of the CWA.

Within the Christina River Basin, there are four regulatory agencies which have adopted applicable WQS. DEP, DNREC and MDE each have WQS which apply to the stream segments of the Christina River Basin in the respective state. DRBC is an interstate agency which has the authority to establish WQS and regulate pollution activities within the Delaware River Basin including the Christina River Basin, one of the Delaware River's tributary basins.

Once EPA identifies the applicable use designation and water quality criteria, EPA determines the numeric water quality target or goal for the TMDL. These targets represent a number where the applicable water quality is achieved and maintained. In these TMDLs, the target is to attain and maintain the applicable DO water quality criteria at low-flow conditions. EPA has set forth specific targets for DO in the Tables and Figures provided in the TMDL Decision Rationale applicable to each segment. The table below identifies the general numeric water quality targets or endpoints for the Christina River Basin TMDLs.

Summary of TMDL Endpoints*

Parameter	Target Limit	Reference
Daily Average DO, freshwater, Pennsylvania	5.0 mg/L	Pennsylvania Water Quality Standards
Daily Average DO, freshwater, Delaware	5.5 mg/L	Delaware Water Quality Standards
DO at any time, freshwater, Maryland	5.0 mg/L	Maryland Water Quality Standards
Minimum DO	4.0 mg/L	Pennsylvania and Delaware Water Quality Standards

* - the state of Maryland adopted the EPA water quality criteria for ammonia nitrogen in January 2001 (effective April 2001 - Title 26 Maryland Department of the Environment Subtitle 08 Water Pollution Chapter 02 Water Quality). This was approved by EPA in June 2001.

In addition to the TMDL DO endpoints summarized in the above table, there are higher DO WQS for certain Christina River Basin segments during the critical conditions time periods considered in these low-flow TMDLs. Generally, these segments were either not listed on 303(d) lists for point source impacts or found not to be impacted by point source discharges in the TMDL evaluations. The results of the TMDL model runs, incorporating the proposed TMDL reductions, indicate that these higher DO WQS will also be protected.

These TMDLs have also identified the pollutants and sources of pollutants that cause or contribute to the impairment of the DO criteria and allocate appropriate loadings to the various sources. Given our scientific knowledge regarding the interrelationship of nutrients, Biochemical Oxygen Demand (BOD), Sediment Oxygen Demand (SOD) and their impact on DO, EPA determined it necessary and appropriate to establish numeric targets for total nitrogen and total phosphorus based on applicable state narrative criteria (or numeric criteria in the case of Maryland) to support the attainment of the numeric DO criterion. Likewise, to maintain adequate instream levels of DO at low-flow conditions, EPA found it necessary and appropriate to develop as part of these TMDLs waste load allocations for total phosphorus, total nitrogen, ammonia-nitrogen, Carbonaceous Biochemical Oxygen Demand (CBOD) and DO for point sources. Establishing numeric water quality endpoints or goals also provides the ability to measure the progress toward attainment of the WQS and to identify the amount or degree of deviation from the allowable pollutant load.

Christina River Basin Water Quality and TMDL Development

As noted above, Pennsylvania identified 24 stream segments on its 1998 303(d) list while Delaware identified 15 stream segments on its 1998 303(d) list as not meeting WQS for nutrients and low DO within the Christina River Basin. The listed stream segments identified various

causes of impairment including excessive nutrients, organic enrichment and low DO. Data appendices prepared for and considered in this report describe in detail the existing water quality during low-flow. These appendices can be viewed at the EPA Region III Christina River Basin TMDL web site (www.epa.gov/reg3wapd/christina).

These TMDLs also address loadings of pollutants from waterbodies or segments which have not been listed as impaired on the states' 303(d) lists. The CWA requires for interstate waters that the water from the upstream state meet the WQS of the downstream state at or before the state line. In this case, these interstate TMDLs not only address the segments listed respectively by Pennsylvania (the upstream state) and Delaware (the downstream state), but also address other water quality problems associated with discharges from non-listed waters necessary to protect the water quality of downstream waters of Delaware during low-flow conditions. In a few cases, including certain segments of the East Branch of the Brandywine River, the TMDL modeling also revealed problems in previously unlisted waters where none had been identified before. In some cases where a segment may not have been previously identified as impaired, these TMDLs allocate pollutant loads that are causing or contributing to the impairment of that water and/or downstream waters. EPA established such waste load allocations in order to attain and maintain the applicable WQS of both upstream and downstream waters consistent with our authority to establish these TMDLs.

As indicated in the data assessment (appendices found at the web site), the nutrient concentrations of the tidal Christina River are heavily influenced by tributary loads from the Brandywine Creek, Red and White Clay Creeks and nontidal Christina River. The data analysis also indicates that DO concentrations within the tidal Christina River violate both the minimum and daily average WQS during low-flow critical conditions. In addition to the influential nutrients loads from tributaries, spatial data analysis indicates that high levels of plant biomass are likely the result of transport from inland tributaries. In any case, the nutrient and biomass loadings from inland tributaries potentially contribute to the DO WQS violations within the tidal Christina River. This further justifies the need to consider sources of pollutants and tributaries on a watershed basis, regardless of whether that waterbody is explicitly listed on the states' 303(d) lists.

TMDL Model

In establishing these TMDLs, EPA utilized the EFDC water quality model, a public domain surface water modeling system incorporating fully integrated hydrodynamic, water quality and sediment-contaminant simulation capabilities, to evaluate the linkage between the applicable water quality criteria and the identified sources and to establish the cause-and-effect relationships. The EFDC model has been applied in similar studies including the Peconic Estuary, the Indian River Lagoon/Turkey Creek, and the Chesapeake Bay system and has been used to develop TMDLs in Oklahoma and Georgia.

Summary of TMDL Allocations

The TMDL waste load and load allocations for specific segments are provided in tables at the end of this Executive Summary. The Level 1 allocations result from the evaluation of each individual discharger. For Level 2, the resultant Level 1 allocations were added one at a time in a cumulative assessment of WLA impacts. The Level 2 allocations are the proposed WLAs for the affected dischargers. Tables are also provided that display the total discharge load reductions proposed by the TMDLs to ensure that the DO WQS are met under low-flow conditions in the Christina Basin.

Federal regulations at 40 CFR 122.44(d)(1)(vii)(B) require that, for an NPDES permit for an individual point source, the effluent limitations must be consistent with the assumptions and requirements of any available WLA for the discharger prepared by the state and approved by EPA or established directly by EPA. To ensure consistency with these TMDLs, as NPDES permits are issued for the point sources that discharge the pollutants of concern to the Christina Basin, any deviation from the WLAs described herein for the particular point source must be documented in the permit Fact Sheet and made available for public review along with the proposed draft permit and the Notice of Tentative Decision. The documentation should: (1) demonstrate that the loading change is consistent with the goals of these TMDLs and will implement the applicable WQS, (2) demonstrate that the changes embrace the assumptions and methodology of these TMDLs, and (3) describe that portion of the total allowable loading determined in the TMDL report that remains for other point sources (and future growth where included in the original TMDL) not yet issued a permit under the TMDL.

Discussion of Regulatory Conditions

Federal regulations at 40 CFR Section 130 require that TMDLs must meet the following eight regulatory conditions:

- 1) The TMDLs are designed to implement applicable water quality standards.
- 2) The TMDLs include a total allowable load as well as individual waste load allocations and load allocations.
- 3) The TMDLs consider the impacts of background pollutant contributions.
- 4) The TMDLs consider critical environmental conditions.
- 5) The TMDLs consider seasonal environmental variations.
- 6) The TMDLs include a margin of safety.
- 7) The TMDLs have been subject to public participation.
- 8) There is reasonable assurance that the TMDLs can be met.

The TMDL Decision Rationale document discusses how these TMDLs satisfy each of these regulatory conditions in Section VII. The Christina River Basin TMDLs for nutrients and DO under low-flow conditions have fulfilled the 40 CFR Section 130 regulatory conditions.

Total Maximum Daily Load of Nutrients and Dissolved Oxygen

**Under Low-Flow Conditions in the Christina River Basin,
Pennsylvania, Delaware, and Maryland**

TMDL Summary by Subwatershed for the Christina River Basin

Sum of Individual Waste Load Allocations					
Subwatershed	CBOD5 lb/day	NH3-N lb/day	TN lb/day	TP lb/day	DO lb/day
Brandywine Creek main stem	79.72	16.82	43.04	9.00	26.74
Brandywine Creek East Branch	1,022.79	157.30	3,562.99	118.76	523.97
Brandywine Creek West Branch	600.16	124.15	1,218.68	69.48	257.01
Buck Run	7.55	0.79	1.91	0.61	1.53
<i>Brandywine Creek Watershed</i>	1,710.22	299.06	4,826.62	197.85	809.25
Christina River West Branch	75.57	13.57	125.33	6.26	37.56
Little Mill Creek	0.00	0.00	0.00	0.00	0.00
Christina River main stem	0.00	0.00	0.00	0.00	0.00
<i>Christina River Watershed</i>	75.57	13.57	125.33	6.26	37.56
Burroughs Run	0.04	0.01	0.02	0.01	0.03
Red Clay Creek West Branch	162.32	19.44	46.94	12.83	71.36
Red Clay Creek main stem	108.96	4.81	11.61	75.52	112.11
<i>Red Clay Creek Watershed</i>	271.32	24.26	58.57	88.36	183.50
White Clay Cr. Middle Branch	53.83	10.52	25.46	4.51	11.27
White Clay Cr. East Branch	88.78	8.69	149.67	11.23	16.17
Muddy Run	0.00	0.00	0.00	0.00	0.00
Pike Creek	0.00	0.00	0.00	0.00	0.00
Mill Creek	0.00	0.00	0.00	0.00	0.00
White Clay Cr. main stem	0.75	0.03	0.06	0.03	1.25
<i>White Clay Creek Watershed</i>	143.36	19.24	175.19	15.77	28.69
Total Waste Load Allocation for Point Sources in Christina River Basin	2,200.47	356.13	5,185.71	308.24	1,059.00

TMDL Summary by Subwatershed for the Christina River Basin

Sum of Load Allocations					
Subwatershed	CBOD5 lb/day	NH3-N lb/day	TN lb/day	TP lb/day	DO lb/day
Brandywine Creek main stem	52.01	1.78	137.30	1.50	497.95
Brandywine Creek East Branch	162.33	3.85	248.01	3.35	1,333.95
Brandywine Creek West Branch	99.18	3.08	262.94	2.77	958.41
Buck Run	34.72	0.96	92.45	0.94	338.75
Brandywine Creek Watershed	348.24	9.67	740.69	8.55	3,129.05
Christina River West Branch	1.17	0.02	0.82	0.02	5.94
Little Mill Creek	36.27	0.52	25.38	0.51	186.02
Christina River main stem	34.99	1.65	26.85	0.86	163.08
Christina River Watershed	72.43	2.19	53.05	1.38	355.05
Burroughs Run	4.60	0.10	9.10	0.21	33.65
Red Clay Creek West Branch	20.05	0.42	39.68	0.90	146.87
Red Clay Creek main stem	40.10	0.91	79.24	1.83	292.00
Red Clay Creek Watershed	64.75	1.43	128.02	2.94	472.52
White Clay Cr. Middle Branch	20.80	0.67	58.11	0.66	237.96
White Clay Cr. East Branch	23.44	0.77	65.42	0.74	267.66
Muddy Run	3.23	0.11	9.00	0.10	36.80
Pike Creek	5.57	0.19	15.52	0.18	63.40
Mill Creek	7.64	0.26	21.31	0.24	87.06
White Clay Cr. main stem	17.96	0.68	49.76	0.59	201.98
White Clay Creek Watershed	78.64	2.68	219.12	2.51	894.86
Total for LA Christina River Basin	564.06	15.97	1,140.88	15.38	4,851.48
Margin of Safety	Implicit through conservative assumptions				
TMDL for Christina River Basin	2,764.53	372.10	6,326.59	323.62	5,910.47

Note: Totals subject to rounding variations.

**Total Maximum Daily Load of Nutrients and Dissolved Oxygen
Under Low-Flow Conditions in the Christina River Basin,
Pennsylvania, Delaware, and Maryland**

Level 1 Baseline Allocations

NPDES Facility	Flow (mgd)	Existing Permit Limits			Level 1 Allocation Limits			Level 1 Percent Reduction		
		CBOD5 (mg/L)	NH3-N (mg/L)	TP (mg/L)	CBOD5 (mg/L)	NH3-N (mg/L)	TP (mg/L)	CBOD5	NH3-N	TP
East Branch Brandywine Creek										
PA0026531	7.134	10	2.0	2.0	8.9	1.78	1.78	11%	11%	11%
West Branch Brandywine Creek										
PA0026859	3.85	15	2.0	2.0	12.3	2.0	1.64	18%	0%	18%
West Branch Red Clay Creek										
PA0024058	1.1	25	3.0	7.5*	17.5	2.1	1.35	30%	30%	82%
West Branch Christina River										
MD0022641	0.7	22**	6.45*	1.0	22**	2.0	1.0	0%	69%	0%

Note:WLAs/ permit limits for critical conditions period; applicable to seasonal permit periods (e.g., May 1 - October 31 - DEP)

* no permit limits, values shown are based on monitoring data.

** value shown is BOD5. MDE permits list BOD5 instead of CBOD5; equivalent CBOD5 value is 12.22 mg/l.

PA0026531 - Downingtown Area Reg. Auth.
PA0024058 - Kennett Square

PA0026859 - PA American Water Co.***
MD0022641 - Meadowview Utilities, Inc.

*** - formerly Coatesville City Authority

**Total Maximum Daily Load of Nutrients and Dissolved Oxygen
Under Low-Flow Conditions in the Christina River Basin,
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Level 2 Allocations

NPDES Facility	Flow (mgd)	Existing Permit Limits			Level 2 Allocation Limits			Level 1 and 2 Percent Reduction		
		CBOD5 (mg/L)	NH3-N (mg/L)	TP (mg/L)	CBOD5 (mg/L)	NH3-N (mg/L)	TP (mg/L)	CBOD5	NH3-N	TP
East Branch Brandywine Creek										
PA0043982	0.4	25	2.0*	2.0	22.95	2.00	1.88	8%	0%	6%
PA0012815	1.028	34	6.0	1.0	24.41	4.31	0.72	28%	28%	28%
PA0026531	7.134	10	2.0	2.0	6.38	1.28	1.28	36%	36%	36%
West Branch Brandywine Creek										
PA0026859	3.85	15	2.0	2.0	11.07	2.00	1.48	28%	0%	28%
PA0044776	0.6	15	3.0	2.0	13.50	2.70	1.80	10%	10%	10%
West Branch Red Clay Creek										
PA0024058	1.1	25	3.0	7.5*	16.63	2.00	1.28	34%	34%	83%
PA0057720-001	0.05	10	2.0	2.0*	9.50	1.90	1.90	5%	5%	5%
West Branch Christina River										
MD0022641**	0.7	22***	6.45*	1.0	22***	2.0	1.0	0%	69%	0%

Note: WLAs/permit limits for critical conditions period; applicable to seasonal permit periods (e.g., May 1 - October 31 - DEP)

* no permit limits, values shown are based on typical characteristics or monitoring data.

**allocation did not change from Level 1 allocation.

***value shown is BOD5. MDE permits list BOD5 instead of CBOD5; equivalent CBOD5 value is 12.22 mg/l.

PA0026531 - Downingtown Area Reg. Auth.

PA0024058 - Kennett Square

PA0043982 - Broad Run Sew. Co.

PA0057720-001 - Sunny Dell Foods, Inc.

**** - formerly Coatesville City Authority

PA0026859 - PA American Water Co. ****

MD0022641- Meadowview Utilities, Inc.

PA0012815 - Sonoco Products

PA0044776 - NW Chester Co. Mun. Auth.

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